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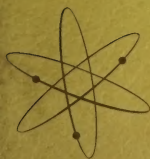
ESSELTE

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HEATH PWR/SUR HM-11
extra

PRICE \$1.00

HEATHKIT® ASSEMBLY MANUAL



REFLECTED POWER
METER AND SWR BRIDGE

MODEL HM-11

RESISTOR AND CAPACITOR COLOR CODES

RESISTORS

The colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped toward one end of the resistor body. Starting with this end of the resistor, the first band represents the first digit of the resistance value; the second band represents the second digit; the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of $\pm 5\%$ or $\pm 10\%$ respectively. The absence of a fourth band indicates a tolerance of $\pm 20\%$.

CODE			
COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD	-	-	.1
SILVER	-	-	.01

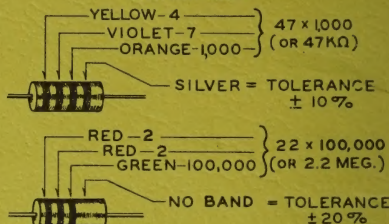


TOLERANCE
 GOLD $\pm 5\%$
 SILVER $\pm 10\%$
 NO BAND $\pm 20\%$

The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/2 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

The color code chart and examples which follow provide the information required to identify color coded resistors.

EXAMPLES



CAPACITORS

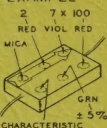
Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes

shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronics Industries Association) Standards.

MICA

CODE			
COLOR	1st DIGIT	2nd DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD	-	-	.1
SILVER	-	-	.01

EXAMPLE



2700 μ fd $\pm 5\%$
 OR .0027 μ fd

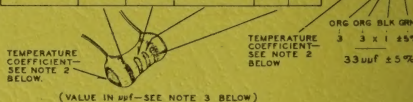


TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.

CODE			
COLOR	1st DIGIT	2nd DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000

EXAMPLE



NOTES:

1. The characteristic of a mica capacitor is the temperature coefficient, drift capacitance and insulation resistance. This information is not usually needed to identify a capacitor but, if desired, it can be obtained by referring to EIA Standard, RS-153 (a Standard of Electronic Industries Association).
2. The temperature coefficient of a capacitor is the predictable change in capacitance with temperature change and is

expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of μ fd (microfarad, .000001 farad) and μ fd (micro-micro-farad, .000001 μ fd); therefore, 1,000 μ fd = .001 μ fd, 1,000,000 μ fd = 1 μ fd.

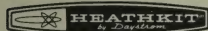
USING A PLASTIC NUT STARTER

A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (3-48 and 6-32). When the correct end is pushed down over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut.

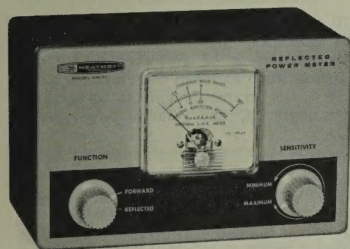
6-32



Assembly and Operation of the



REFLECTED POWER METER AND SWR BRIDGE MODEL HM-11



HEATH COMPANY,
BENTON HARBOR,
MICHIGAN

DAYSTROM, INCORPORATED
a subsidiary of

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All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

SPECIFICATIONS

Operation.	Indicates percentage of forward and reflected power, and voltage standing wave ratio (SWR).
RF Power Handling Capability.	One kilowatt.
Input And Output Impedance.	50 or 75 Ω .
Band Coverage.	160 through 6 meters.
Meter.	100 microamperes, full scale.
Dimensions.	7-3/4" wide x 4-5/8" high x 4-1/16" deep.
Net Weight.	1-1/2 lbs.
Shipping Weight.	3 lbs.

INTRODUCTION

Your Heathkit Model HM-11 Reflected Power Meter and SWR Bridge indicates, reliably but inexpensively, whether the RF power output of your transmitter is being transferred efficiently to the radiating antenna. The Reflected Power Meter was designed for use with Radio Amateur transmitters primarily, but it can also be used with other similar transmitters. If you use the Reflected Power meter with a transceiver it will not affect receiver operation.

Since the power handling capability of the Reflected Power Meter is higher than the legal upper limit for Radio Amateur transmitter power, it can be inserted permanently in the

50 to 70 Ω coaxial transmission line with negligible insertion loss. This will permit continuous monitoring of reflected power or SWR (standing wave ratio) to determine proper transmitter tuning, transmission line-to-antenna impedance matching, and relative power output.

The Reflected Power Meter can also be used for other applications, such as designing antenna coupling networks, checking other transmission systems, etc. Because of its small size and the fact that it needs no external power source, it can be moved about conveniently. Standard VHF input and output coaxial connectors are used.

THEORY OF OPERATION

The circuit of the Reflected Power Meter and SWR Bridge is based upon that of a device developed at the U.S. Naval Research Laboratory, Washington, D.C., and described by NorGorden in N.R.L. report No. 3538, titled "A Reflectometer for H-F Band." Simplified versions have also been described in various amateur radio publications.

In the broadest terms, the Reflected Power Meter

consists of a short section of transmission line to which two small linear inductors are coupled, both inductively and capacitively. The radio frequency current flowing in each inductor and its load resistor is rectified by a germanium diode and filtered by a ceramic capacitor. The Function switch selects the direct current output of either diode and applies it to a variable-sensitivity metering circuit, consisting of a linear potentiometer and a 0-100 microammeter.

The circuit shown on the Schematic Diagram is actually two radio frequency bridges, and indicator which is switched from one bridge to the other. We will refer to the two bridges as the Reflected bridge and the Forward bridge, using the Function switch terminology. The proportion of capacitive and inductive coupling between the transmission line and the linear inductors is such that the reflected bridge will be balanced for the condition of no reflected power (perfect line-to-load impedance match); the meter will therefore indicate a standing wave ratio of unity and zero percent reflected power for this condition. If the transmission line is either shorted or open at the antenna end, essentially all of the power will be reflected, and the meter will indicate approximately 100% reflected power, representing an infinitely large SWR. If the antenna is not resonant or does not match the transmission line used, some power will be reflected back from the antenna and the bridge will be unbalanced. The meter will indicate the degree of unbalance as Percent Reflected Power and approximate SWR.

When the Function switch is in the Forward position, the meter will indicate radio frequency current flowing in the forward direction, toward the antenna. As forward current is increased, the meter swings up-scale. The actual

meter indication will depend upon the amount of current flowing toward the antenna in the transmission line, and the setting of the Sensitivity control. Therefore, the Reflected Power Meter is a reliable transmitter tuning indicator in addition to serving as a continuous monitor of transmitter output.

It should be noted that the meter does not have a scale calibration for forward current. Because of the wide range of frequencies and transmitter power output levels that may be encountered, a meaningful power output or forward current scale would greatly complicate the design of the instrument and thereby unduly increase its cost. It is far more important to know that the transmitter is putting out maximum power for a given input than it is to know the exact amount of power involved.

Regardless of the operating frequency or the power output level (within the stated power capability of the Reflected Power Meter), an increase in the amount of current flowing toward the antenna will always produce a higher indication on the meter. The Sensitivity control establishes a reference meter reading that is correct for the frequency and power used. This reference level is fullscale on the meter.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be highly stable and dependable performance. We suggest that you retain the manual in your files for future reference, both in the use of the equipment and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacements section and supply the information called for therein. Include all inspection slips in your letter to us.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a penknife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

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Operation.	Indicates percentage of forward and reflected power, and voltage standing wave ratio (SWR).
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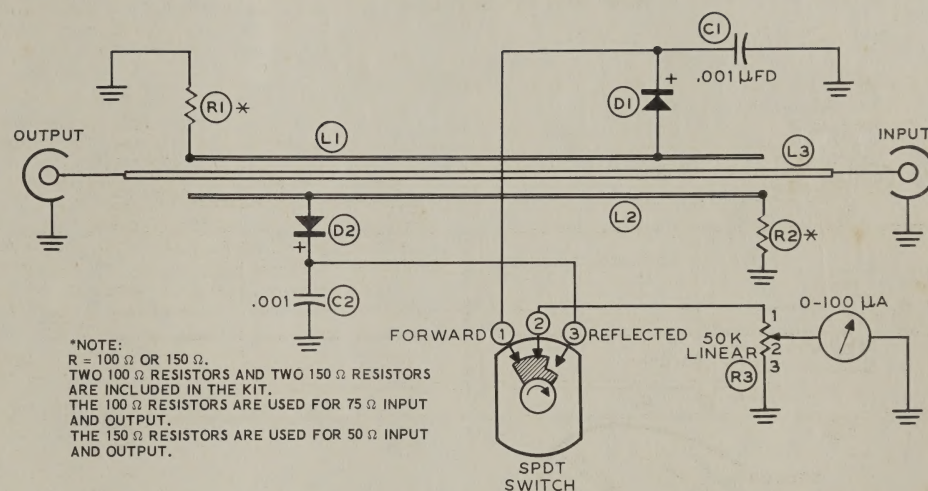
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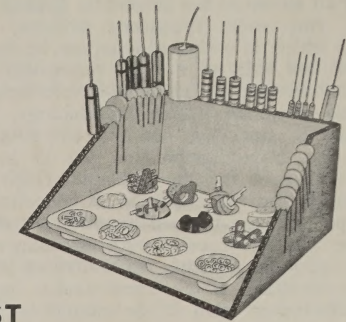
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**SCHEMATIC OF THE
HEATHKIT® REFLECTED POWER
AND STANDING WAVE RATIO BRIDGE
MODEL HM-11**

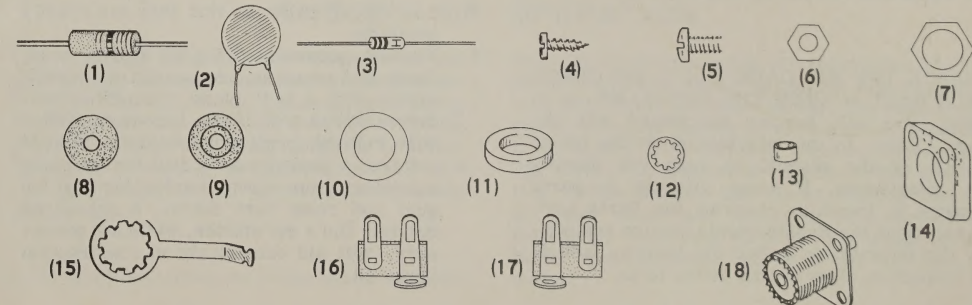
Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.



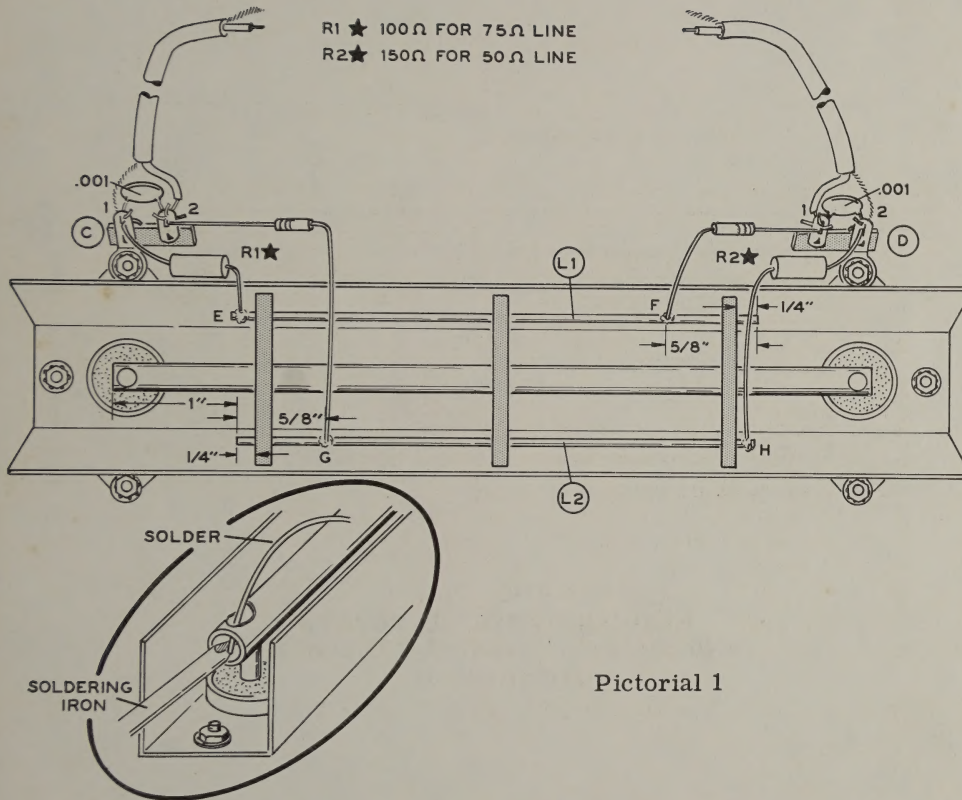
PARTS LIST

The numbers in parentheses in the Parts List are keyed to the numbers on the parts drawings to aid in parts identification.

PART No.	PARTS Per Kit	DESCRIPTION	PART No.	PARTS Per Kit	DESCRIPTION
(1) 1-123	2	100 Ω 1/2 watt resistor 5% (brown-black-brown-gold)	(11) 253-22	1	Control spacer washer
1-111	2	150 Ω 1/2 watt resistor, 5% (brown-green-brown-gold)	(12) 254-9	8	#4 lockwasher
(2) 21-14	2	.001 μ fd disc ceramic capacitor	(13) 255-2	2	#6 x 3/16" spacer
40-98	1	RF driver element	(14) 255-12	3	Plastic spacer
40-99	2	RF pickup element	(15) 259-10	2	Control solder lug
40-M100	1	Coaxial cavity	(16) 431-14	1	2-lug terminal strip
(3) 56-4	2	Crystal diode	(17) 431-16	1	2-lug terminal strip
10-11	1	50 K Ω control	(18) 436-5	2	Coax connector
63-3	1	Rotary switch	343-6	1	Length shielded cable
(4) 250-8	1	#6 sheet metal screw	344-1	1	Length hookup wire
(5) 250-52	8	4-40 x 1/4" screw	407-43	1	Meter
(6) 252-15	8	4-40 nut	261-1	4	Rubber feet
(7) 252-7	2	Control nut	462-122	2	Knob
(8) 253-3	2	#10 fiber flat washer	90-248	1	Cabinet
(9) 253-7	2	#10 fiber shoulder washer	203-125F832	1	Front panel
(10) 253-10	2	Control flat washer	204-M136	1	Meter bracket
			331-6		Solder
			595-594	1	Manual



R1 ★ 100 Ω FOR 75 Ω LINE
R2 ★ 150 Ω FOR 50 Ω LINE



Pictorial 1

PROPER SOLDERING TECHNIQUES

Only a small percentage of customers find it necessary to return equipment for factory service. By far the largest portion of malfunctions in this equipment are due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 25 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly. Keep the iron tip clean by wiping it from time to time with a cloth.

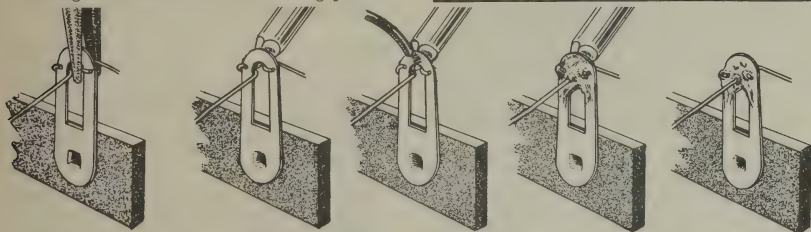
CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, all wire used is the type with colored insulation (hookup wire). In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the assembly step.
2. Leads on resistors, capacitors, and similar components are generally much longer than need be to make the required connections. In these cases, the leads should be cut to proper length before the part is installed. In general, the leads should be just long enough to reach their terminating points.

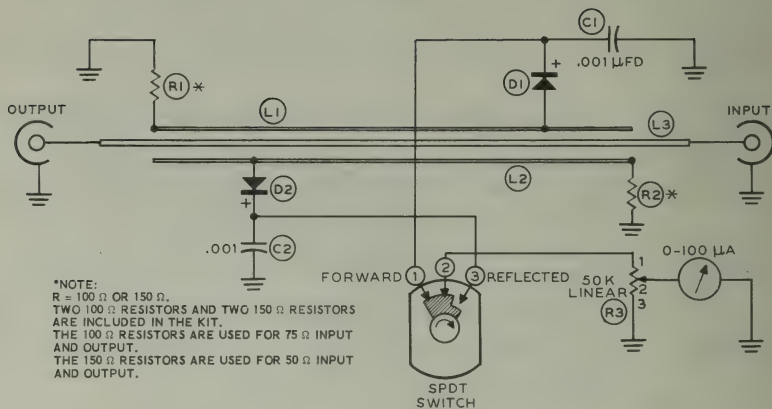
3. Crimp or bend the wire around the terminal just enough to hold it in place until it is soldered.
4. Position the work, if possible, so that gravity will help to keep the solder where you want it.
5. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.
6. Then place the solder against the terminal and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.
7. Remove the solder and then the iron from the completed joint. Use care not to move the leads until the solder is solidified.

A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly. In some cases, it may be necessary to add a little more solder to achieve a smooth, bright appearance.

ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.



CRIMP WIRES HEAT CONNECTION APPLY SOLDER ALLOW SOLDER TO FLOW PROPER SOLDER CONNECTION



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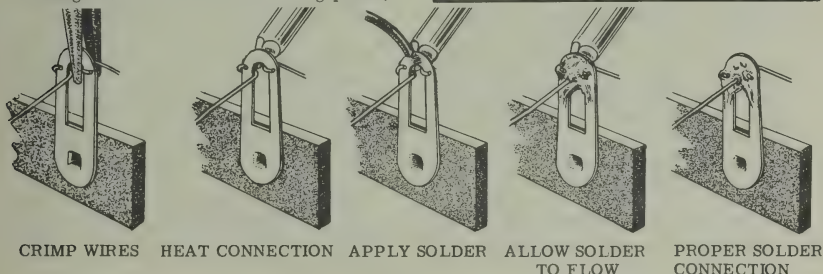
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STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each wire and part in colored pencil on the Pictorial as it is added.

ILLUSTRATIONS

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustra-

tions may be slightly distorted to facilitate clearly showing all of the parts.

SOLDERING INFORMATION

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a wire to lug 1 (S-2)," it will be understood that there will be two wires connected to the terminal at the time it is soldered. (In cases where a wire passes through a terminal or lug and then connects to another point, it will count as two wires, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation (R1, C1, etc.) on the Schematic, its designation will appear at the beginning of the assembly step which directs its installation.

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1 (fold-out from Page 4) for the following steps.

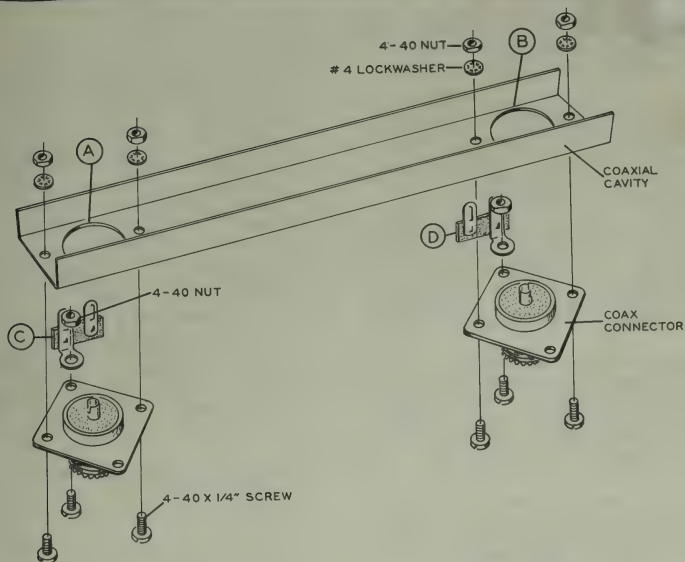
- (✓) Referring to Detail 1A, install a coax connector at one end of the coaxial cavity. Use 4-40 x 1/4" screws, #4 lockwashers, and 4-40 nuts.
- (✓) Similarly, mount a coax connector at the other end of the coaxial cavity.
- (✓) Temporarily place the RF driver element over the center terminals of the coax connectors. If it does not fit properly, loosen the nuts and move the connectors slightly.
- (✓) Temporarily mount 2-lug terminal strip C to coax connector A. Use a 4-40 x 1/4" screw and 4-40 nut. Use the proper 2-lug terminal strip and position it as shown.
- (✓) In a like manner, mount 2-lug terminal strip D to coax connector B.

(✓) Referring to Detail 1B, place a #6 x 3/16" spacer on each coax connector.

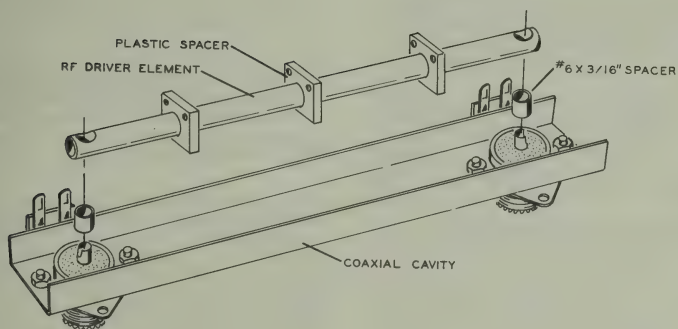
(✓) Slide the three plastic spacers onto the RF driver element. Then fit the end holes of the RF driver element onto the coax connectors. Be sure the small holes in the plastic spacers are up, as shown.

(✓) Solder the ends of the RF driver element to the coax connectors as shown in the inset drawing of Pictorial 1. The plastic spacers are easily melted, so slide them away from the heat, and let the whole assembly cool off before repositioning the spacers and soldering the second end.

(✓) L1. Slide one of the RF pickup elements into the top small holes of the plastic spacers. Position the RF pickup element and the plastic spacers according to the dimensions shown.



Detail 1A



Detail 1B

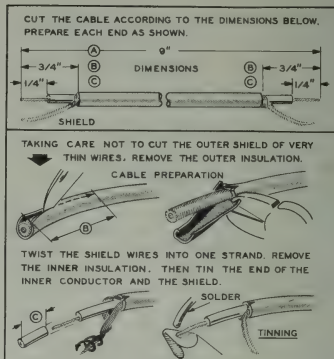
- (✓) L2. Slide the other RF pickup element into the lower holes of the plastic spacers. Position as shown.

Select the proper pair of resistors for use in the next two steps. If the Reflected Power Meter is to be used on a 70 to 75 Ω line, use the 100 Ω (brown-black-brown-gold) 5% resistors. If it is to be used on a 50 Ω line, use the 150 Ω (brown-green-brown-gold) 5% resistors.

- (✓) R1. Cut one lead of one of the correct resistors to 3/4". Bend a hook in the end of this lead and connect it at E on RF pickup element L1 (S-1). Connect the other lead of the resistor to lug 1 of terminal strip C (NS). Position the resistor as shown.
- (✓) R2. Cut one lead of the other resistor to 1-1/8". Bend a hook in the end of this lead and connect it at H on RF pickup element L2 (S-1). Connect the other lead of the resistor to lug 2 of terminal strip D (NS). Position the resistor as shown.

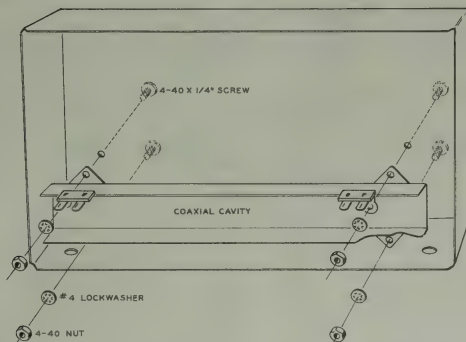
CAUTION: To prevent heat damage to a diode when soldering, hold the diode lead between the diode body and the connection with a pair of long-nose pliers. A rubber band around the handle of the pliers will hold them in place while soldering.

- (✓) D2. Bend a hook in the end of the lead at the unbanded end of a crystal diode. Connect this lead at point G on RF pickup element L2 (S-1). Connect the other lead of the diode to lug 2 of terminal strip C (NS).
- (✓) D1. Cut the lead of the unbanded end of a crystal diode to 3/4". Bend a hook in the end of this lead. Connect this lead to point F on RF pickup element L1 (S-1). Connect the other lead of the diode to lug 1 of terminal strip D (S-1) NS.
- (✓) C2. Connect a .001 μ fd disc ceramic capacitor between lugs 1 (NS) and 2 (NS) of terminal strip C.
- (✓) C1. Connect a .001 μ fd disc ceramic capacitor between lugs 1 (NS) and 2 (NS) of terminal strip D.



Detail 1C

- (✓) Referring to Detail 1C, prepare two 9" lengths of shielded cable as shown.
- (✓) At one end of a 9" prepared cable, connect the inner conductor to lug 2 (S-3) and the shield to lug 1 (S-3) of terminal strip C. Leave the other end free. Be sure to protect the diode from heat.
- (✓) At one end of the remaining 9" cable, connect the inner conductor to lug 1 (S-3) and the shield to lug 2 (S-3) of terminal strip D. Leave the other end free. Be sure to protect the diode from heat.
- (✓) Remove the screws and nuts that hold the terminal strips to the coax connectors.
- (✓) Referring to Detail 1D, install the coaxial cavity into the cabinet. Use 4-40 x 1/4" screws, #4 lockwashers, and 4-40 nuts. Be sure to position the terminal strips as shown.



Detail 1D

Refer to Pictorial 2 and Detail 2A (fold-out from Page 11) for the following steps.

(✓) R3, Install the 50 K Ω control (#10-11) at J on the front panel. Use a control solder lug, control flat washer, and a control nut. Position the control solder lug and control lugs as shown.

(✓) Install the rotary switch (#63-3) at K on the front panel. Use a control spacer, control solder lug, control flat washer, and a control nut. Position the control solder lug and switch lugs as shown.

(✓) Carefully remove the meter from its carton.

(✓) Install the meter at L in the front panel. Use the hardware supplied with the meter. Be sure the meter is mounted right side up in the panel, then carefully tighten the nuts.

(✓) Remove the shorting wire from between the meter lugs.

(✓) Remove the first nut and the solder lug from each meter screw while holding the second nut to prevent it from turning (the meter may be damaged if the screws turn).

(✓) Install the meter bracket on the meter. Use #10 fiber shoulder washers, #10 fiber flat washers, and the solder lugs and nuts that were removed from the meter. Again be sure the front nuts of the meter do not

turn and that the fiber shoulders, which insulate the meter screws, fit into the bracket holes.

Refer to Pictorial 2 for the following steps.

(✓) Connect a 5-1/4" wire from lug 3 of control J (S-1) to lug 2 of switch K (S-1).

(✓) Strip 1" insulation from one end of a 4" wire. Connect this end of the wire to lug 1 of control J (S-1), and around the control solder lug at control J (S-2). Connect the other end of the wire to lug 2 of meter L (S-1).

(✓) Connect a 3" wire from lug 2 of control J (S-1) to lug 1 of meter L (S-1).

Connect the free end of the shielded cable coming from terminal strip C as follows:

(✓) Connect the inner conductor to lug 1 of switch K (S-1) and the shield to the control solder lug at switch K (NS).

Connect the free end of the shielded cable coming from terminal strip D as follows:

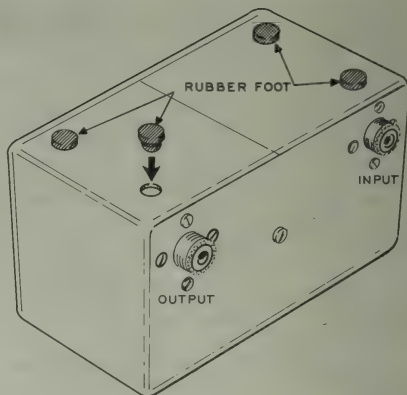
(✓) Connect the inner conductor to lug 3 of switch K (S-1) and the shield to the control solder lug at switch K (S-2).

This completes wiring of the Reflected Power Meter. Check to see that all connections are soldered and that no shorts exist. Especially, make sure the resistor and diode leads are not touching the coaxial cavity.

NOTE: The spare set of resistors may be taped to the inside of the cabinet to be available if the Reflected Power Meter is to be used later on the other line impedance.

- (✓) Fit the front panel onto the cabinet and secure it in place with a #6 sheet metal screw through the back of the cabinet.
- () Turn the control and switch shafts fully counterclockwise.
- () Install a knob on the shaft of the FUNCTION switch with the pointer in the FORWARD position, and tighten the setscrew.
- () Install a knob on the SENSITIVITY control with the pointer in the MINIMUM position, and tighten the setscrew.
- () Referring to Detail 2B, install the four rubber feet in the bottom of the cabinet.
- () Mark the input and output connectors on the rear of the cabinet.

This completes the assembly of your Reflected Power Meter.



Detail 2B

INSTALLATION

Connect the Reflected Power Meter in series between the transmitter and antenna system. Input and output coaxial connectors are provided on the rear of the cabinet. Place the Reflected Power Meter in a convenient location at the transmitter operating station. Cut the coaxial transmission line at the proper place, and install male coax connectors on the cable ends. Then connect the transmitter output cable

to the Reflected Power Meter input and connect the antenna cable to the output.

If an antenna tuner is used, connect the Power Meter between the transmitter and antenna tuner with coax cable of the proper impedance. Then the tuner can be adjusted for minimum SWR and maximum output.

OPERATION

The Reflected Power Meter is designed for use with impedances of 50 or 70-75 Ω only, and will not perform properly in lines of other impedances. It will not work on transmission lines used as tuned feeders, since tuned feeders are supposed to have high SWR's, and cannot be adjusted for minimum SWR.

Before applying power to the transmitter, turn the SENSITIVITY control to MINIMUM and the

FUNCTION switch to FORWARD. Apply power to the transmitter and tune it up. Disregard the HM-11 readings at this stage. After the transmitter is properly tuned, the SENSITIVITY control may be advanced for a midscale meter reading. A minor "touch-up" tuning of the transmitter may show an increase in output on the meter. This indicates a closer match between the transmitter and the transmission line. The SENSITIVITY control should then be advanced to give a fullscale (SET) meter reading.

After carefully adjusting the SENSITIVITY control to SET with the FUNCTION switch in the FORWARD position, turn the FUNCTION switch to REFLECTED. This may be done while power is on, as the switch is connected in the low-power bridge circuit and no switching transient damage can result by this practice. The amount of power returned, or reflected, cannot be read directly in percentage on the meter, or as the SWR.

The Reflected Power Meter is designed so that it may be left in the transmission line at all times for continuous monitoring of operation of the transmitter system. A power output of 70 watts is needed on 75 meters for fullscale deflection with the FUNCTION switch in FORWARD position, and only 2 or 3 watts on 6 meters. The minimum power needed varies with frequency. At low power levels, any meter reading within the range of the Sensitivity control can be used as a normal-operation reference; midscale may be convenient. The meter readings would then be approximately proportional to the ratio between the meter reference level you choose and fullscale.

As the transmitter is being voice modulated, a slight downward deflection of the meter will be indicated. This will occur when the FUNCTION switch is in the FORWARD position and should not be confused with downward modulation. This effect is generally due to a nonlinear relationship between the voltage and current developed in the final amplifier of the transmitter, and should not alarm the operator, as it is entirely normal with high level modulation. Control carrier modulation will "kick" the meter indication upward on peaks. SSB and DSB signals will give a bouncing indication when transmitting and no SWR measurement can be made. Use a single-tone or CW carrier with sideband transmitters. Any indication with no modulation indicates spurious or parasitic emission, or poor carrier suppression.

There are three items of importance when considering SWR in practical operation:

1. There may be meter reading variations if the Reflected Power Meter is placed at different locations in the transmission line, or if the length of the transmission line is changed. For this reason, assume that the highest SWR reading is most correct. Keep

in mind that the closer the SWR approaches 1:1; the more accurate the Reflected Power Meter becomes.

With long transmission lines, misleading readings may be obtained, since the losses in the cable tend to "smooth out" the standing waves, giving a much better indication at the transmitter than actually exists at the antenna. Therefore, when using a transmission line long enough to have appreciable losses, the Reflected Power Meter should be located near the antenna, particularly when adjusting beams or tuning traps. The extent of this effect can be appreciated by realizing that a line with a 3 db loss will show a SWR of 3 when it is terminated in a dead short. A line with a loss of over 10 db will show a SWR of practically 1:1, on this or any other SWR meter, regardless of what load or termination is connected at the far end.

The power in these cases is lost in the cable, however, the SWR meter reading will not indicate anything wrong. When in doubt, make measurements at the antenna, then at the transmitter, so that future changes in the readings will be meaningful. The values of cable losses at various frequencies can be obtained from Figure 1 on Page 12. These losses become worse as time and moisture affect the cable.

2. With a high SWR, the losses in the transmission line may become so great that the power radiated by the antenna is appreciably reduced; with high-power transmitters, the cable ratings may be exceeded. Figure 2 on Page 13 shows the effect of increasing cable losses caused by various values of SWR. All these extra losses are RF power turned into heat in the cable instead of radiated signal at the antenna.
3. The load presented to the transmitter output circuit may create conditions that make it touchy or impossible to load the transmitter. With a low SWR, the load that the transmitter sees is practically pure resistive. However, at a high SWR, the apparent load may vary from a very low to a very high resistance, accompanied by either capacitive or inductive reactance. These values change when the transmission line length or frequency is changed.

Remember, the SWR cannot be changed by changing the transmission line length. However, the loading to the transmitter may be changed considerably, thus making it appear that "pruning" the cable length offers improvement, when it actually does not affect the SWR.

Only by changing the load or termination at the end of the cable can the SWR be changed. For example, with 50 Ω cable and a SWR of 3, the apparent load to the transmitter

may vary from 16-2/3 Ω to 150 Ω resistive, with reactance varying from 66-2/3 Ω capacitive, to zero, to 66-2/3 Ω inductive, just by changing the transmission line length. If the transmitter output tuning adjustments will not accomodate this impedance range, difficulty in transmitter loading will be experienced until the load is properly matched to the line. When the load is matched the SWR will be lower.

References: QST, "Amateur Applications Of The Smith Chart," January 1960, Page 28. Charts from ARRL Handbook.

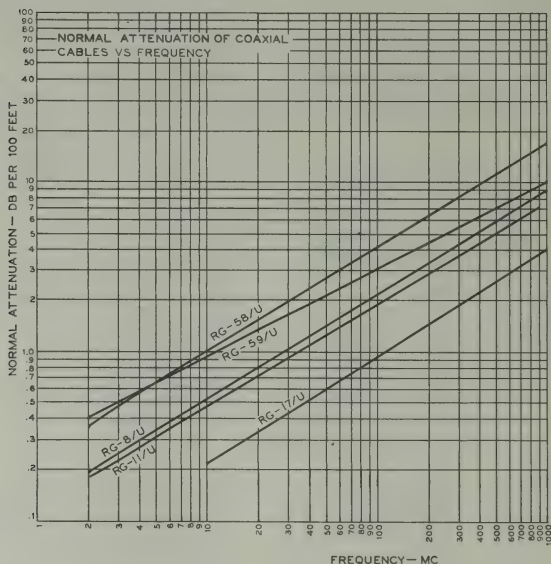
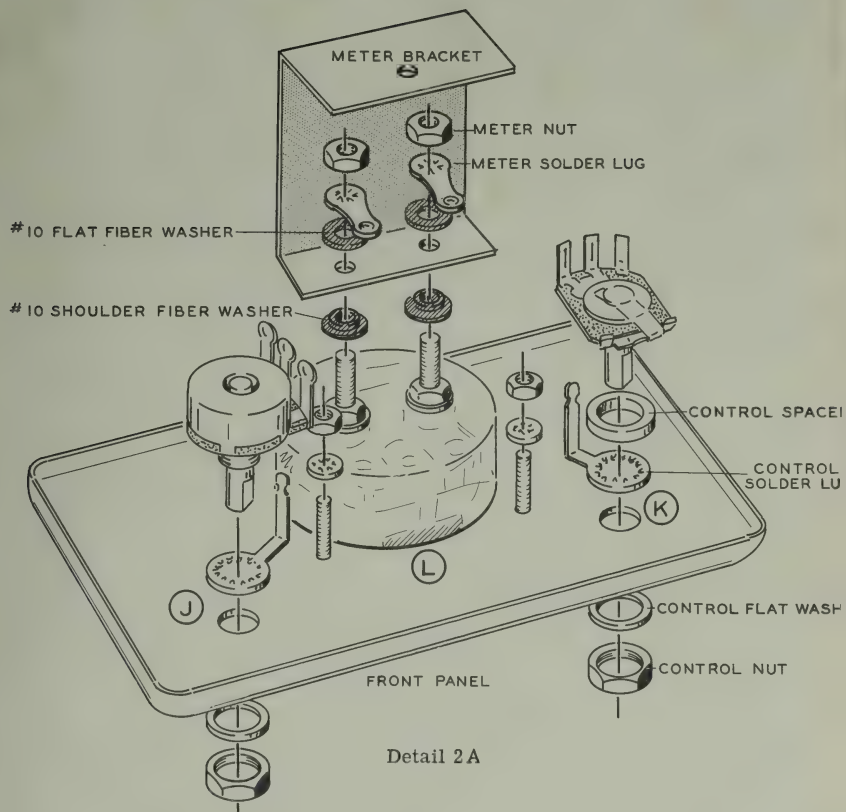


Figure 1



Detail 2 A

Remember, the SWR cannot be changed by changing the transmission line length. However, the loading to the transmitter may be changed considerably, thus making it appear that "pruning" the cable length offers improvement, when it actually does not affect the SWR.

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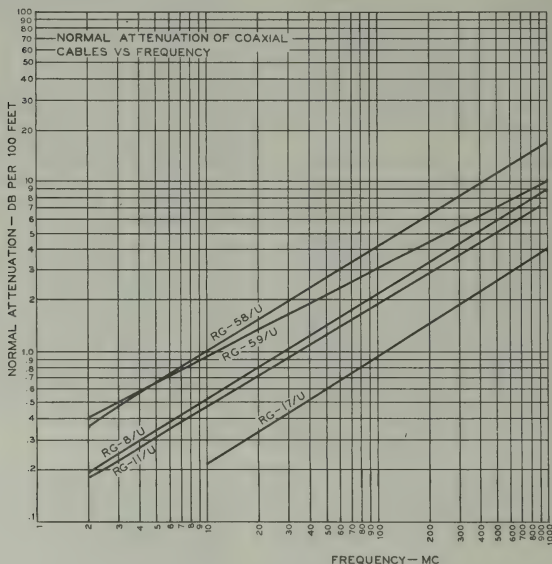
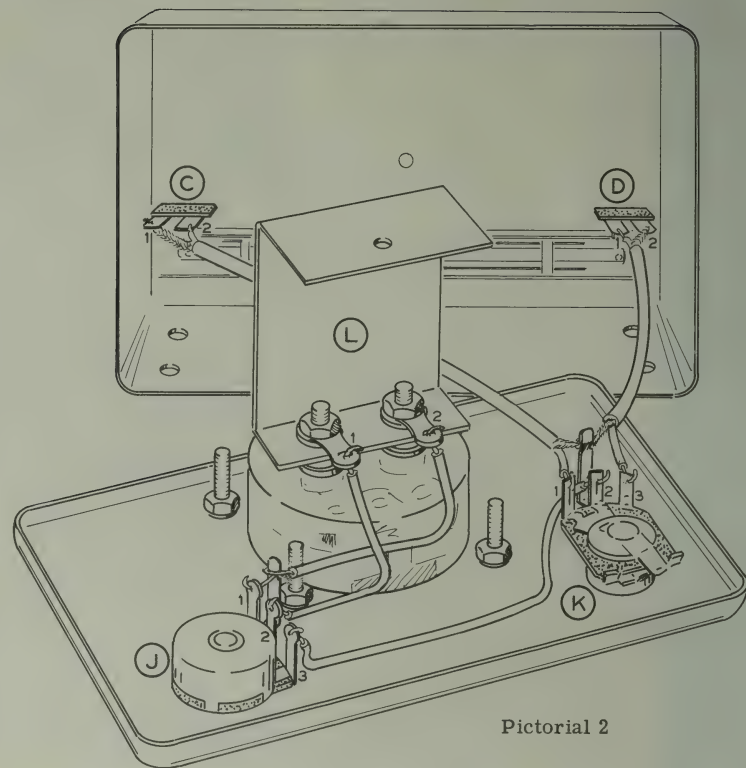
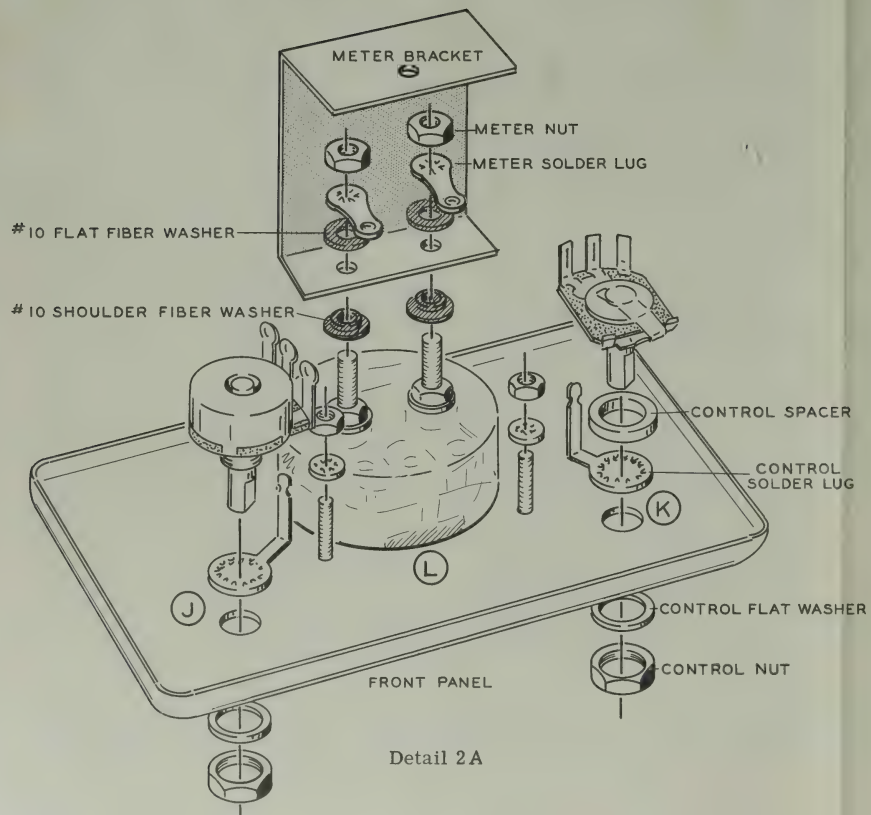
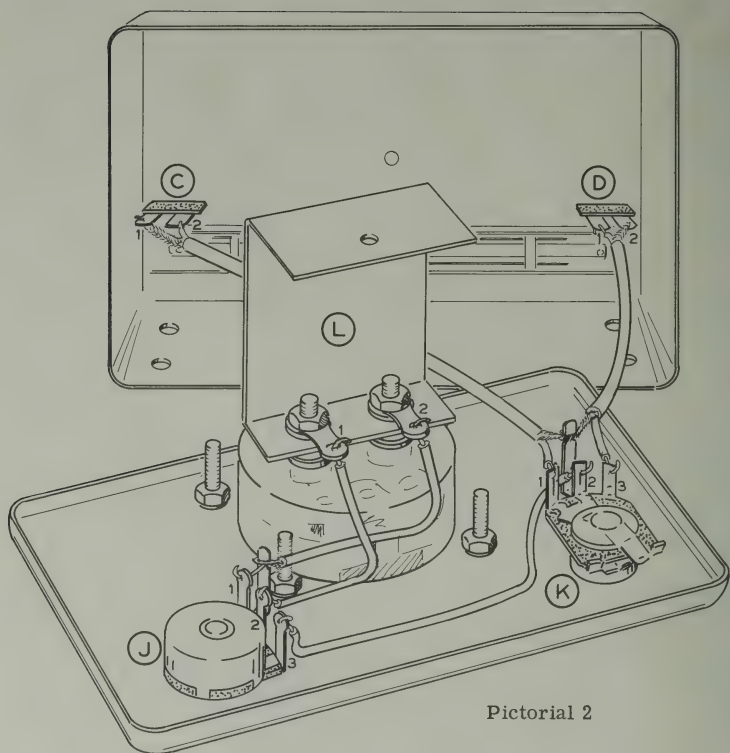


Figure 1





Pictorial 2

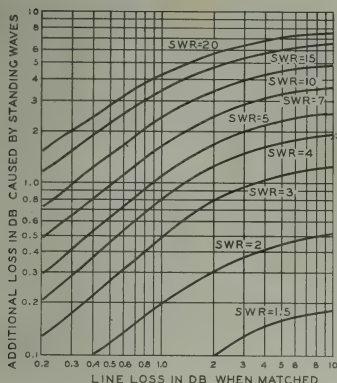


Figure 2

CALIBRATION

To calibrate, first connect the output of the transmitter to the input of the Reflected Power Meter, and connect some form of load to the output. The load can be a dummy load such as the Heathkit "Antenna," or the antenna to be used for transmitting. Turn the transmitter on and tune it for maximum output. Adjust the SENSITIVITY control of the Reflected Power Meter for a SET meter reading with the FUNCTION switch in the FORWARD position. Now turn the FUNCTION switch to the REFLECTED position and observe the reading. Turn the transmitter off and reverse the transmitter and load

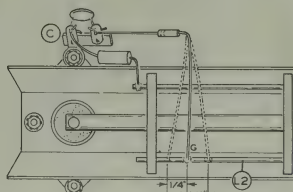


Figure 3

connections to the Reflected Power Meter. Turn the transmitter on without retuning and set the SENSITIVITY control for a SET meter reading again. Now turn the FUNCTION switch back to the FORWARD position and observe this reading. If these two readings, with the FUNCTION switch in the REFLECTED position for the first setup and in the FORWARD position for the second setup are not the same, unsolder the diode on the Reflected pick-up link (See Figure 3) and move it slightly one way or the other until the two readings are the same. The diode should not have to be moved more than 1/4" overall.

IN CASE OF DIFFICULTY

If the Calibration procedure does not equalize the two readings, one of the diodes may be connected backwards or may be defective. Also, check to be sure that both 100 Ω resistors are used for a 75 Ω line, or both 150 Ω resistors for a 50 Ω line. Check the resistance of each resistor with an ohmmeter to be sure they are matched to within a few percent of each other.

Make sure the pickup elements are parallel to the drive element.

Mistakes in wiring or poorly soldered connections are the most common causes of difficulty. Consequently, the first step is to recheck all wiring against the Pictorial and Schematic Diagrams. Often having a friend check the wiring will locate an error consistently overlooked.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of this manual.
3. Check the values of the parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.
4. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.
5. A review of the Circuit Description will prove helpful in indicating where to look for trouble.

SERVICE INFORMATION

SERVICE

If, after applying the information in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.
2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units, and anything else that might help to isolate the cause of trouble.
3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.
4. Identify the kit model number and date of purchase, if available. Also mention the date of the kit assembly manual. (Date at bottom of Page 1.)
5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you

wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed equipment to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although charges for local service are generally somewhat higher than for factory service, the amount of increase is usually offset by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be

accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

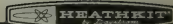
For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally, improper operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

- A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.
- B. Identify the type and model number of kit in which it is used.
- C. Mention date of purchase.
- D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do



not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrument must be returned for service, these instructions should be carefully followed.

Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the

carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

ATTACH A LETTER TO THE OUTSIDE OF THE CARTON BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Also, include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by insured parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.



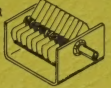


























NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

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TYPICAL COMPONENT TYPES


This chart is a guide to commonly used types of electronic components. The symbols and related illustrations

should prove helpful in identifying most parts and reading the schematic diagrams.

RESISTOR  	CAPACITOR  	 TUBE PLATE SUPPRESSOR SCREEN GRID CATHODE FILAMENT 
POTENTIOMETER (CONTROL)  	ELECTROLYTIC CAPACITOR  	PNP TRANSISTOR  NPN TRANSISTOR  
TRANSFORMER (IRON CORE)  	VARIABLE CAPACITOR  	RECTIFIER (DIODE)  
TRANSFORMER (ADJUSTABLE POWDERED IRON CORE) ARROW INDICATES DIRECTION OF CORE MOVEMENT TO INCREASE INDUCTANCE  	BATTERY  	 NEON BULB 
TRANSFORMER (ADJUSTABLE CORE)  	PHONO JACK  	 ILLUMINATING BULB 
POWER TRANSFORMER  	PHONE JACK  	 METER 
INDUCTOR (COIL)  	RECEPTACLE  	SPST SWITCH (TOGGLE)  DPDT  
PIEZOELECTRIC CRYSTAL  	SPEAKER  	SWITCH (ROTARY)  
BINDING POST  	MICROPHONE  	FUSE  
ANTENNA GENERAL  LOOP 	EARTH GROUND  CHASSIS GROUND 	CONDUCTORS NOT CONNECTED  CONNECTED  SHIELDED 

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